WHAT IS CLAIMED IS:

1. A piston design support program for supporting design of a piston shape of an internal combustion engine, said program makes a computer execute:

an input step of inputting specification values associated with a piston shape;

a verification step of verifying, based on the input specification values, whether or not gaps between the piston and surrounding components thereof are appropriate;

a read step of reading out, when it is determined in the verification step that the gaps are appropriate, a three-dimensional piston model which can be deformed according to a predetermined rule from a database; and

a deformation step of deforming the piston model on the basis of the specification values.

2. The program according to claim 1, wherein the input step includes a step of inputting specification values associated with a crown shape of the piston and a shape and position of a valve, and

the verification step includes a step of verifying whether or not a gap between the piston and the valve is not less than a predetermined value.

3. The program according to claim 2, wherein the verification step includes:

a two-dimensional data generation step of generating two-dimensional shape data of the piston and the valve on the basis of the specification values; and

a calculation step of calculating the gap between piston and the valve using the two-dimensional shape data of the piston and the valve.

4. The program according to claim 3, wherein the two-dimensional data generation step includes a step of generating the two-dimensional data of the piston and the valve by reading out a two-dimensional piston model and valve model, which can be deformed according to a predetermined rule, from the database, and deforming the readout models on the basis of the specification values.

5. The program according to claim 1, wherein specification values associated with a skirt shape of the piston and a shape and position of a connecting rod are input, and

the verification step includes a step of verifying whether or not a gap between the piston and the connecting rod is not less than a predetermined value.

6. The program according to claim 5, wherein the verification step includes:

a two-dimensional data generation step of generating two-dimensional shape data of the piston and

the connecting rod on the basis of the specification values; and

a calculation step of calculating the gap between the piston and the connecting rod using the two-dimensional shape data of the piston and the connecting rod.

7. The program according to claim 6, wherein the two-dimensional data generation step includes a step of generating the two-dimensional data of the piston and the connecting rod by reading out a two-dimensional piston model and connecting rod model, which can be deformed according to a predetermined rule, from the database, and deforming the readout models on the basis of the specification values.

8. The program according to claim 1, wherein specification values associated with a skirt shape of the piston and a shape and position of a counter weight are input, and

the verification step includes a step of verifying whether or not a gap between the piston and the counter weight is not less than a predetermined value.

9. The program according to claim 8, wherein the verification step includes:

a two-dimensional data generation step of generating two-dimensional shape data of the piston and

the counter weight on the basis of the specification values; and

a calculation step of calculating the gap between the piston and the counter weight using the two-dimensional shape data of the piston and the counter weight.

10. The program according to claim 9, wherein the two-dimensional data generation step includes a step of generating the two-dimensional data of the piston and the counter weight by reading out a two-dimensional piston model and counter weight model, which can be deformed according to a predetermined rule, from the database, and deforming the readout models on the basis of the specification values.

11. The program according to claim 1, wherein the verification step includes a step of reading out a verification formula from the database, substituting the specification values in the verification formula, and verifying whether or not the input specification values are appropriate.

12. The program according to claim 1, wherein said program makes the computer further execute:

a selection step of selecting one of types which are classified depending on shapes of a surface of the piston on the combustion chamber side after verification in the verification step, and

in that the database stores the piston models in correspondence with the types, and

the read step includes a step of reading out the piston model corresponding to the type selected in the selection step from the database.

13. The program according to claim 1, wherein said program makes the computer further execute a determination step of determining whether or not the gap is not less than the predetermined value, on a three-dimensional space using the three-dimensional piston model deformed in the deformation step.

14. A piston design support method for supporting design of a piston shape of an internal combustion engine, comprising:

an input step of inputting specification values associated with a piston shape;

a verification step of verifying, based on the input specification values, whether or not gaps between the piston and surrounding components thereof are appropriate;

a read step of reading out, when it is determined in the verification step that the gaps are appropriate, a three-dimensional piston model which can be deformed according to a predetermined rule from a database; and

a deformation step of deforming the piston model on the basis of the specification values using deformation means.

15. A piston design support apparatus for supporting design of a piston shape of an internal combustion engine, comprising:

an input unit for inputting specification values associated with a piston shape;

a verification unit for verifying, based on the input specification values, whether or not gaps between the piston and surrounding components thereof are appropriate;

a read unit for, when said verification unit determines that the gaps are appropriate, reading out a three-dimensional piston model which can be deformed according to a predetermined rule from a database; and

a deformation unit for deforming the piston model on the basis of the specification values.

16. The program according to claim 2, wherein the input step includes a step of inputting, as the specification values, information associated with the piston, information associated with the valve, information associated with surfaces of a cylinder head that form a combustion chamber, and a target value of a capacity-related value which determines a capacity of the combustion chamber,

the verification step includes:

a recess model building step of building a recess model, which opposes the valve and has a gap with the valve to satisfy a predetermined condition, on a top

portion of the piston model on the basis of the information associated with the piston and the information associated with the valve input in the input step,

the deformation step includes:

a piston top portion model building step of setting a shape of a piston top portion so that the capacity of the combustion chamber becomes a target capacity determined from the target value of the capacity-related value, and building a three-dimensional piston top portion model, on the basis of the recess model built in the recess model building step, and the information associated with the piston, the information associated with the surfaces which form the combustion chamber, and the target value of the capacity-related value input in the input step, and

said program makes the computer further execute:

a valve model building step of building a three-dimensional valve model on the basis of the information associated with the valve input in the input step; and

a gap calculation step of calculating a gap between a recess of the piston top portion model built in the piston top portion model building step and the valve model built in the valve model building step.

17. The program according to claim 16, wherein the recess model building step includes a step of building the recess model on a flat piston top portion.

18. The program according to claim 16, wherein said program makes the computer further execute:

a condition determination step of determining whether or not the gap calculated in the gap calculation step satisfies a predetermined condition of the gap between the recess and the valve in the recess model building step; and

a valve model rebuilding step of rebuilding, when it is determined in the condition determination step that the gap does not satisfy the predetermined condition, the valve model by changing at least one of a valve thickness and a slope angle of a chamfer formed at a corner portion as an intersection of a recess opposing surface and side circumferential surface so that the gap satisfies the predetermined condition.

19. The program according to claim 18, wherein when the valve thickness of the valve model rebuilt in the valve rebuilding step is smaller than a prescribed value, said program changes the gap between the recess and the valve in the recess model building step, and makes the computer execute the recess model building step, the piston top portion model building step, the valve model building step, the gap calculation step, and the condition determination step again.

20. The program according to claim 16, wherein the input step includes a step of further inputting information associated with a position and shape of a piston ring groove to be formed on a side circumferential surface of the piston,

the deformation step includes:

a piston building step of building a three-dimensional piston model which comprises the recess and the piston ring groove independently of or to include the piston top portion model built in the piston top portion model building step on the basis of the recess model built in the recess model building step, and the information associated with the piston and the information associated with the position and shape of the piston ring groove input in the input step, and

said program makes the computer further execute a recess thickness calculation step of calculating a minimum value of a thickness between the recess and the piston ring groove in the piston ring on the basis of the piston model built in the piston building step.

21. The program according to claim 16, wherein the input step includes a step of further inputting information associated with at least a shape of a piston ring groove to be formed on a side circumferential surface of the piston,

the deformation step includes:

a piston building step of building a three-dimensional piston model which comprises the recess independently of or to include the piston top portion model built in the piston top portion model building step on the basis of the recess model built in the recess model building step, and the information associated with the piston in the input step, and

said program makes the computer further execute a groove position calculation step of calculating a position of the piston ring groove on the basis of the piston model built in the piston building step and the information associated with the shape of the piston ring groove input in the input step so that a minimum value of a thickness between the recess in the piston model and the piston ring groove is not less than a predetermined value.

22. The method according to claim 14, wherein the input step includes a step of inputting, as the specification values, information associated with the piston, information associated with the valve, information associated with surfaces of a cylinder head that form a combustion chamber, and a target value of a capacity-related value which determines a capacity of the combustion chamber,

the verification step includes:

a recess model building step of building a recess model, which opposes the valve and has a gap with the

valve to satisfy a predetermined condition, on a top portion of the piston model on the basis of the information associated with the piston and the information associated with the valve input in the input step,

the deformation step includes:

a piston top portion model building step of setting a shape of a piston top portion so that the capacity of the combustion chamber becomes a target capacity determined from the target value of the capacity-related value, and building a three-dimensional piston top portion model, on the basis of the recess model built in the recess model building step, and the information associated with the piston, the information associated with the surfaces which form the combustion chamber, and the target value of the capacity-related value input in the input step, and

said method further comprises:

a valve model building step of building a three-dimensional valve model on the basis of the information associated with the valve input in the input step; and

a gap calculation step of calculating a gap between a recess of the piston top portion model built in the piston top portion model building step and the valve model built in the valve model building step.

23. The apparatus according to claim 15, wherein said input unit inputs, as the specification values, information associated with the piston, information associated with the valve, information associated with surfaces of a cylinder head that form a combustion chamber, and a target value of a capacity-related value which determines a capacity of the combustion chamber, and

said verification unit comprises:

a recess model building unit for building a recess model, which opposes the valve and has a gap with the valve to satisfy a predetermined condition, on a top portion of the piston model on the basis of the information associated with the piston and the information associated with the valve input by said input unit;

a piston top portion model building unit for setting a shape of a piston top portion so that the capacity of the combustion chamber becomes a target capacity determined from the target value of the capacity-related value, and building a three-dimensional piston top portion model, on the basis of the recess model built by said recess model building unit, and the information associated with the piston, the information associated with the surfaces which form the combustion chamber, and the target value of the capacity-related value input by said input unit;

a valve model building unit for building a three-dimensional valve model on the basis of the information associated with the valve input by said input unit;

a gap calculation unit for calculating a gap between a recess of the piston top portion model built by said piston top portion model building unit and the valve model built by said valve model building unit; and

a gap verification unit for verifying whether or not the gap calculated by said gap calculation unit falls within a predetermined range.

24. A piston design support program for supporting design of a piston shape of an internal combustion engine by making a computer execute:

an input step of inputting specification values associated with a piston shape;

a read step of reading out a piston model, which can be deformed according to a predetermined rule, from a database; and

a deformation step of deforming the piston model on the basis of the specification values input in the input step,

wherein the piston model includes an intake-side piston model which includes an intake-side recess formed to prevent interference with an intake valve, and an exhaust-side piston model which includes an

exhaust-side recess formed to prevent interference with an exhaust valve, and

the deformation step includes a step of deforming both the intake- and exhaust-side piston models and combining the deformed intake- and exhaust-side piston models.

25. The program according to claim 24, wherein the intake- and exhaust-side piston models are segmented in accordance with symmetry, and

the deformation step includes a step of combining the intake- and exhaust-side piston models, and mirroring the combined model in accordance with the symmetry.

26. The program according to claim 24, wherein the specification values include crown types indicating if a surface of the piston on the combustion chamber side has a convex or recess shape,

the database stores a plurality of intake-side piston models and a plurality of exhaust-side piston models in correspondence with the crown types, and

the read step includes a step of reading out from the database the intake- and exhaust-side piston models corresponding to the crown type input in the input step as the specification value.

27. The program according to claim 24, wherein the deformation step includes a step of:

deforming, when dimensions associated with the entire piston are input as the specification values, both the intake- and exhaust-side piston models in correspondence with each other.

28. The program according to claim 24, which makes computer further execute a display step of displaying a piston model obtained by combining the intake- and exhaust-side piston models in the deformation step while hiding connected surfaces of the intake- and exhaust-side piston models.

29. The program according to claim 24, wherein the intake-side recess included in the intake-side piston model and the exhaust-side recess included in the exhaust-side piston model use different shape determination rules upon determining shapes of the intake- and exhaust-side recesses on the basis of a recess depth input as the specification value.

30. The program according to claim 29, wherein the input step includes a step of inputting an intake-side recess depth and an exhaust-side recess depth, and

the shapes of the intake- and exhaust-side recesses are determined to have different slopes of bottom surfaces even when identical values are input as the intake- and exhaust-side recess depths in the input step.

31. The program according to claim 29, wherein the input step includes a step of inputting an intake-side recess depth and an exhaust-side recess depth, and

the shapes of the intake- and exhaust-side recesses are determined to have different curvatures of corners formed by bottom surfaces and side surfaces thereof even when identical values are input as the intake- and exhaust-side recess depths in the input step.

32. The program according to claim 29, wherein when the intake- and exhaust-side recess depths input in the input step have changed, the shape of the intake-side recess is determined to change at least one of a slope of a bottom surface and a curvature of a corner formed by the bottom surface and a side surface thereof, but the shape of the exhaust-side recess is determined to change neither of a slope of a bottom surface and a curvature of a corner formed by the bottom surface and a side surface thereof.

33. The program according to claim 24, wherein the input step includes a step of inputting a target compression ratio as the specification value, and

the deformation step includes a step of deforming the piston model in accordance with the target compression ratio input in the input step.

34. The program according to claim 33, which makes the computer further execute:

a compression ratio calculation step of calculating a compression ratio of the piston model deformed in the deformation step, and

wherein a piston shape closest to the target compression ratio input in the input step is determined by repeating the deformation step and the compression ratio calculation step.

35. A piston design support program for supporting design of a piston shape of an internal combustion engine by making a computer execute:

an input step of inputting specification values associated with a piston shape;

a read step of reading out a piston model, which can be deformed according to a predetermined rule, from a database; and

a deformation step of deforming the piston model on the basis of the specification values input in the input step,

wherein the database includes, as the piston model, a main body model which represents a shape of a surface of the piston on the combustion chamber side, and a space model which represents a space shape to be shaved from the main body model, and

the deformation step includes a step of deforming both the main body model and the space model in accordance with the specification values, and shaving

the main body model into a shape expressed by the space model.

36. The program according to claim 35, wherein the space model includes a skirt inner space model which represents a shape inside a skirt of the piston.

37. The program according to claim 35, wherein the space model includes a skirt outer space model which represents a shape of a skirt outer surface of the piston.

38. The program according to claim 35, wherein the space model includes a pin hole space model which represents a shape of a pin hole that receives a pin used to hold a connecting rod.

39. The program according to claim 35, wherein the input step includes a step of inputting dimensions of the entire piston as the specification values, and

the deformation step includes a step of deforming the main body model and the space model in accordance with the dimensions of the entire piston, and shaving the space model from the main body model.

40. The program according to claim 36, wherein the input step includes a step of inputting a thickness of the piston as the specification value, and

the deformation step includes a step of shaving the skirt inner space model from the main body model while laying out the skirt inner space model at a position separated from the main body model by a

distance corresponding to the thickness input in the input step.

41. The program according to claim 36, wherein the input step includes a step of inputting dimensions that determine a shape of the skirt inner space model, and a minimum thickness of the piston as the specification values, and

the deformation step includes a step of producing error information or performing re-deformation when a thickness of a piston model generated by deforming the skirt inner space model in accordance with the specification values input in the input step, and shaving the skirt inner space model from the main body model becomes not more than the minimum thickness.

42. The program according to claim 35, wherein the main body model includes an intake-side piston model which includes an intake-side recess formed to prevent interference with an intake valve, and an exhaust-side piston model which includes an exhaust-side recess formed to prevent interference with an exhaust valve, and

the deformation step includes a step of deforming both the intake- and exhaust-side piston models and combining the deformed intake- and exhaust-side piston models.

43. The program according to claim 42, wherein the intake- and exhaust-side piston models are segmented in accordance with symmetry, and

the deformation step includes a step of combining the intake- and exhaust-side piston models, and mirroring the combined model in accordance with the symmetry.

44. The program according to claim 36, wherein the input step includes a step of inputting a target compression ratio as the specification value,

the skirt inner space model includes a portion that represents a space shape of a crown back surface, and

the deformation step includes a step of increasing a curvature of the crown back surface of the skirt inner space model with increasing target compression ratio input in the input step.

45. The program according to claim 36, wherein the input step includes a step of inputting a pin boss gap as the specification value,

the skirt inner space model includes a portion that represents a space shape of a crown back surface, and

the deformation step includes a step of increasing a curvature of the crown back surface of the skirt inner space model with decreasing pin boss gap input in the input step.

46. The program according to claim 36, wherein the input step includes a step of inputting a skirt inner diameter as the specification value,

the skirt inner space model includes a portion that represents a space shape of a crown back surface, and

the deformation step includes a step of increasing a curvature of the crown back surface of the skirt inner space model with decreasing skirt inner diameter input in the input step.